

WHAT IS CLAIMED:

1 1. A method of reducing damage resulting from
2 environmental electromagnetic effects on a non-metallic
3 surface, said method comprising:

4 disposing a polymeric sheet material over the
5 non-metallic surface; and

6 disposing a metal layer between the non-
7 metallic surface and the polymeric sheet material.

1 2. A method according to claim 1, wherein the
2 non-metallic surface is the surface of an ungrounded
3 object.

1 3. A method according to claim 1, wherein the
2 object is an aircraft or a marine vessel.

1 4. A method according to claim 1, wherein the
2 polymeric sheet material comprises a polymer selected
3 from the group consisting of polyolefins, polyimides,
4 polyesters, polyacrylates, halopolymers, and combinations
5 thereof.

1 5. A method according to claim 1, wherein the
2 polymeric sheet material is a polymeric fabric.

1 6. A method according to claim 1, wherein the
2 polymeric sheet material is a halopolymer fabric.

1 7. A method according to claim 1, wherein the
2 polymeric sheet material is a fluoropolymer fabric.

1 8. A method according to claim 1, wherein
2 said disposing comprises:

3 adhering the polymeric sheet material directly
4 to the non-metallic surface.

1 9. A method according to claim 1, wherein the
2 metal layer is a metal mesh or an expanded metal foil.

1 10. A method according to claim 1, wherein the
2 metal layer is bonded to the polymeric sheet material and
3 wherein said disposing a polymeric sheet material and
4 said disposing a metal layer are carried out in a single
5 step.

1 11. A method according to claim 10, wherein
2 the polymeric sheet material is a halopolymer sheet
3 material and wherein the metal layer is bonded to the
4 polymeric sheet material by a method comprising:

5 substituting at least a portion of halogen
6 atoms on the outermost surface of the halopolymer sheet
7 material with hydrogen and oxygen or oxygen-containing
8 groups to thus provide an oxyhalopolymer sheet material;
9 and

10 contacting the oxyhalopolymer sheet material
11 with a solution or gas comprising a metal for a period of
12 time sufficient to facilitate bonding of the metal to the
13 oxyhalopolymer sheet material.

1 12. A method according to claim 10, wherein
2 the polymeric sheet material's surface comprises
3 functional groups which will bind an electroless
4 metallization catalyst and wherein the metal layer is
5 bonded to the polymeric sheet material by a method
6 comprising:

7 contacting the polymeric sheet material's
8 surface's functional groups with an electroless
9 metallization catalyst to obtain a catalytic surface; and

10 contacting the catalytic surface with an
11 electroless metallization solution under conditions
12 effective to metallize the polymeric sheet material's
13 surface.

1 13. A method according to claim 10, wherein
2 the metal layer is adhered directly to the non-metallic
3 surface with an adhesive.

1 14. A method according to claim 1, wherein the
2 polymeric sheet material is a first polymeric sheet
3 material and wherein said method further comprises:

4 disposing a second polymeric sheet material
5 over the first polymeric sheet material.

1 15. A method according to claim 14, wherein
2 said method further comprises:

3 disposing a second metal layer between the
4 first polymeric sheet material and the second polymeric
5 sheet material.

1 16. A method according to claim 15, wherein
2 said method further comprises:

3 disposing a third polymeric sheet material over
4 the second polymeric sheet material; and

5 disposing a third metal layer between the
6 second polymeric sheet material and the third polymeric
7 sheet material.

1 17. A method according to claim 1, wherein the
2 environmental electromagnetic effect is a lightning
3 strike.

1 18. An object comprising:

2 a substrate having a non-metallic surface;

3 a halopolymer sheet material disposed over said
4 substrate's non-metallic surface; and

5 a metal layer disposed between said halopolymer
6 sheet material and said substrate's non-metallic surface.

1 19. An object according to claim 18, wherein
2 said substrate is ungrounded.

1 20. An object according to claim 18, wherein
2 said substrate is an aircraft or a marine vessel.

1 21. An object according to claim 18, wherein
2 said halopolymer sheet material is a halopolymer fabric.

1 22. An object according to claim 18, wherein
2 said halopolymer sheet material is a fluoropolymer
3 fabric.

1 23. An object according to claim 18, wherein
2 said metal layer is adhered directly to said substrate's
3 non-metallic surface with an adhesive.

1 24. An object according to claim 18, wherein
2 said metal layer is a metal mesh or an expanded metal
3 foil.

1 25. An object according to claim 18, wherein
2 said metal layer is adhered to said halopolymer sheet
3 material.

1 26. An object according to claim 18, wherein
2 said metal layer is bonded to said halopolymer sheet
3 material.

1 27. An object according to claim 26, wherein
2 said metal layer is bonded to said halopolymer sheet
3 material by a method comprising:

4 substituting at least a portion of halogen
5 atoms on said halopolymer sheet material's outermost
6 surface with hydrogen and oxygen or oxygen-containing
7 groups to thus provide an oxyhalopolymer sheet material;
8 and

9 contacting the oxyhalopolymer sheet material
10 with a solution or gas comprising a metal for a period of

11 time sufficient to facilitate bonding of the metal to the
12 oxyhalopolymer sheet material.

1 28. An object according to claim 26, wherein
2 said halopolymer sheet material's surface comprises
3 functional groups which will bind an electroless
4 metallization catalyst and wherein said metal layer is
5 bonded to said halopolymer sheet material by a method
6 comprising:

7 contacting said halopolymer sheet material's
8 surface's functional groups with an electroless
9 metallization catalyst to obtain a catalytic surface; and

10 contacting the catalytic surface with an
11 electroless metallization solution under conditions
12 effective to metallize said halopolymer sheet material's
13 surface.

1 29. An object according to claim 26, wherein
2 said metal layer is adhered directly to said substrate's
3 non-metallic surface with an adhesive.

1 30. An object according to claim 26, wherein
2 said halopolymer sheet material is a halopolymer fabric.

1 31. An object according to claim 26, wherein
2 said halopolymer sheet material is a fluoropolymer
3 fabric.

1 32. An object according to claim 18 further
2 comprising:

3 a polymeric sheet material disposed over said
4 halopolymer sheet material.

1 33. An object according to claim 32 further
2 comprising:

3 a second metal layer disposed between said
4 halopolymer sheet material and said polymeric sheet
5 material.

1 34. An object according to claim 33, wherein
2 said polymeric sheet material is a first polymeric sheet
3 material and wherein said object further comprises:

4 a second polymeric sheet material disposed over
5 said first polymeric sheet material; and

6 a third metal layer disposed between said first
7 polymeric sheet material and said second polymeric sheet
8 material.

1 35. A laminate comprising:

2 a metal layer having a first surface and a
3 second surface;

4 a halopolymer sheet material bonded or adhered
5 to the first surface of said metal layer; and

6 an adhesive disposed on the second surface of
7 said metal layer.

1 36. A laminate according to claim 35, wherein
2 said halopolymer sheet material is a fluoropolymer sheet
3 material.

1 37. A laminate according to claim 35, wherein
2 said halopolymer sheet material is a halopolymer fabric.

1 38. A laminate according to claim 35, wherein
2 said halopolymer sheet material is a fluoropolymer
3 fabric.

1 39. A laminate according to claim 35, wherein
2 said metal layer's first surface is bonded to said
3 halopolymer sheet material.

1 40. A laminate according to claim 39, wherein
2 said metal layer's first surface is bonded to said
3 halopolymer sheet material by a method comprising:

4 substituting at least a portion of halogen
5 atoms on said halopolymer sheet material's outermost
6 surface with hydrogen and oxygen or oxygen-containing
7 groups to thus provide an oxyhalopolymer sheet material;
8 and

9 contacting the oxyhalopolymer sheet material
10 with a solution or gas comprising a metal for a period of
11 time sufficient to facilitate bonding of the metal to the
12 oxyhalopolymer sheet material.

1 41. A laminate according to claim 39, wherein
2 said halopolymer sheet material's surface comprises
3 functional groups which will bind an electroless
4 metallization catalyst and wherein said metal layer's
5 first surface is bonded to said halopolymer sheet
6 material by a method comprising:

7 contacting said halopolymer sheet material's
8 surface's functional groups with an electroless
9 metallization catalyst to obtain a catalytic surface; and
10 contacting the catalytic surface with an
11 electroless metallization solution under conditions
12 effective to metallize said halopolymer sheet material's
13 surface.

14 42. A laminate comprising:

15 a halopolymer fabric having a first surface and
16 a second surface;

17 a metal layer bonded or adhered to the first
18 surface of said halopolymer fabric; and

19 an adhesive disposed on the second surface of
20 said halopolymer fabric.

1 43. A laminate according to claim 42, wherein
2 said halopolymer fabric is a fluoropolymer fabric.

1 44. A laminate according to claim 42, wherein
2 said metal layer bonded to the first surface of said
3 halopolymer fabric.